Original Article

Sonographic Evaluation of Maternal Splenic Dimensions in Normal Pregnancy

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Abstract

Aim: We aimed to establish sonographically the range of splenic dimensions in healthy pregnancy and to investigate their relationships with gestational age, maternal age body mass index (BMI), and parity of the mother. **Materials and Methods:** A prospective cross-sectional descriptive study of splenic dimensions was performed on 339 healthy, normal pregnant women aged 23–42 years. The spleen was measured with women in supine position on the couch. Scanning of the spleen was done with the women in deep inspiration so that the spleen descends. A Sonoline Omnia ultrasound imaging system with serial number 526,206,526 and model number Cc-13 H71 fitted with a 3.5 MHz ultrasound probe was used in scanning the spleen along the lower left costal margin from the 9th to the 11th rib at the anterior, mid, and posterior axillary lines with the woman in the right lateral decubitus position using the oblique intercostal approach. Data were analyzed using SPSS software version 20.0 (SPSS Inc., Chicago, IL, USA). The relationship between splenic dimensions and gestational age, maternal age, and BMI was assessed using Pearson's correlation coefficient. $P \leq 0.05$ was considered statistically significant. **Results:** The result of the study shows that the mean length, width, thickness, and volume of the spleen of the mothers were 11.9 ± 0.7 cm, 5.7 ± 0.7, 9.5 ± 0.8 cm, and 381.6 ± 111.4 cm^3, respectively. Gestational age was significantly correlated positively with splenic length and splenic volume of the mother (r = 0.37 and 0.31, P = 0.000). **Conclusion:** Splenic dimensions are higher in pregnant women compared to values reported for nonpregnant women and increases with gestational age and BMI of the mother.

Keywords: Fetus, gestational age, maternal, obstetrics, spleen, ultrasound

Introduction

In many instances, the dimension of the spleen may be affected as it performs its functions, which include clearance of microorganisms and particulate antigens from the bloodstream, removal, and destruction of aged or defective red blood cells from circulation and synthesis of immunoglobulin.[1] The spleen is also the site of hematopoiesis in fetuses, and stores platelets in the entire lifetime.[1] The spleen is one of the organs of the reticuloendothelial system. It is tetrahedral in shape, and the largest secondary lymphoid organ located in the left hypochondrium. The size of the spleen may vary depending on physical and immune processes.[2] However, available literature have documented values to be 12 cm, 5 cm, and 7 cm for length, thickness, and width, respectively.[3]

Splenomegaly is the enlargement of the spleen, measured by size or weight.[4] Splenic weight of 400–500 g indicates splenomegaly, while a weight >1000 g is considered a massive splenomegaly. Studies have linked splenomegaly with some infectious processes like malaria sickle cell disease, chronic renal disease, and chronic liver disease.[5] In addition, malignancies such as lymphomas, leukemia, and other conditions such as portal hypertension may result in splenomegaly.[6] Normal pregnancy is a physiological state affecting various systems and organs of the body.[7] The spleen is one organ usually affected by pregnancy, probably due to the extra workload imposed on it in pregnancy. A few studies have implicated pregnancy in splenomegaly, with evidence reporting massive splenomegaly to be associated with growth-restricted fetuses.[8] It might be useful to assess the quantitative changes

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that the spleen undergoes during normal pregnancy. This could be an important index to determine the pregnancy state and fetal well-being. Pregnancy can be said to affect the spleen through increased maternal blood volume, which is a major characteristic of the pregnant state. During pregnancy, the spleen has more workload or increased demand for immune responses against microorganisms among other functions. Some researchers have reported that maternal blood volume could depend on the splenic size and pregnancy hormones.[9,10] However, maternal splenic dimension is hardly considered in obstetrical workups, and is grossly underrepresented in research.

Ultrasound scan is the best imaging tool in the evaluation of abdominal organs in pregnancy. This is because it is noninvasive, nonionizing, easily available, cheap, safe, quick, and an accurate method for the measurement of the spleen.[11] There is a dearth of comprehensive data on ultrasound estimates of splenic size in pregnancy. Since the spleen plays significant roles in maintaining a healthy pregnancy, it is necessary to estimate its dimensions in this group of individuals. The present study sought to determine maternal splenic size in healthy mothers with uncomplicated pregnancies and investigate its relationship with gestational age, maternal age, and body mass index (BMI). The paucity of published information from this region on this subject matter is also a motivation for this study.

Materials and Methods

This was a prospective descriptive cross-sectional study. A total of 339 healthy women with uncomplicated pregnancies were randomly selected or this study. Women with singleton pregnancy that are not taking alcoholic, nonhypertensive, nondiabetic and women without any complication of pregnancy were recruited for the study. Only women with pregnancies from 6 weeks of gestation to 40 weeks in four clinics in Calabar and Port Harcourt metropolises in southern Nigeria between August and December 2018 were conveniently recruited for this study. Women with histories of hematopoietic or infectious disorder, trauma, prolonged febrile illness, chronic renal disease, chronic liver disease or any known malignancy that may compromise splenic size were excluded from the study. Ethical approval was obtained from the Research and Ethical Committee of Assurance Medical Diagnostic Centre, Goldie Street, Calabar, Nigeria. Only women who gave consent participated in the study.

Equipment, procedures, and data synthesis

All sonographic measurements were performed by a single well-experienced sonographer with over 20 years of experience in sonography. A Sonoline Omnia ultrasound imaging system with serial number 526,206,526 (model number: Cc-13 H71-M, Siemens, USA) fitted with a 3.5MHz curvilinear transabdominal probe was used for the sonographic measurements. The weight and height were obtained using a stadiometer. Data obtained included splenic dimensions, gestational age, maternal age, weight, height, and BMI. BMI was calculated using the formula: BMI = weight (kg)/height^2 (m). Brief clinical history was obtained from the patients, and explanation of the procedures was given to every consenting participant. Scanning was done with the women in deep inspiration so that the spleen descends. Scanning was done along the lower left costal margin from the 9th to the 11th rib at the anterior, mid, and posterior axillary lines with the woman in the right lateral decubitus position. The spleen was measured with women in a supine position on the couch, and arms placed away from the chest wall. Linear dimension of the spleen was measured (length, width, and thickness). Splenic volume was calculated using the standard prolate ellipsoid formula (length × width × depth × 0.523). All measurements were made on sections through the splenic hilum in order to create a constant reference point for repeating measurements. Splenic length (SL) was defined as the maximum distance between the dome of the spleen [Figure 1] and the splenic tip across the hilum on longitudinal section, while splenic width was defined as the maximum distance between the medial and lateral borders of the spleen at the level of the hilum, and was measured at a plane perpendicular to the length on longitudinal section. A transverse scan was used to obtained splenic thickness as the maximum anteroposterior dimension. Measurement of the spleen dimensions was acquired with the patient in the supine position and was then repeated with the patient in the right lateral decubitus position on deep inspiration. The mean of the two measurements was documented. Gestational age was determined based on the trimester at the instance of the study. For the first trimester, the crown-rump length was used, while for the second and third trimesters, the Hadlock's method based on biparietal diameter, head circumference, abdominal circumference, and femur length was used to determine gestational age. Synthesized data were documented and transferred to Excel spread for analysis.

Data analysis

Statistical analysis was done using the Statistical Package for Social Sciences version 20.0 Inc., Chicago, IL, USA. All statistical tests for significance of differences were done at a level of 95% confidence interval. Pearson's correlation (*r*) was used to analyze the relationship between splenic dimensions and parameters such as gestational age, maternal age, weight, height, and BMI in the chosen sample.

Results

A total of 339 apparently healthy women with singleton pregnancies between the ages of 23 and 42 years took part in this study. Their mean age was determined as 29.4 ± 9.6 years. Maternal SL ranged from 6.00 to 17.40 cm [Table 1]. Mothers with BMI <20 (underweight mothers) had the lowest SL (mean = 8.00 ± 0.4 cm) while those with BMI >30 (overweight mothers) had the highest SL (mean = 11.81 ± 0.5 cm). The findings of this study show that maternal SL, width, and thickness increased linearly with gestational age. Pearson correlation analysis shows that maternal SL and volume had a significant positive relationship

Table 1: Distribution of splenic dimension with gestational age

Splenic dimension	Gestational age (weeks)	*n*	Mean±SD	Range
SL (cm)	6-12	118	9.3±0.6	6.0-16.3
	13-27	112	9.8±0.3	8.9-15.7
	28-40	109	10.6±0.4	9.9-17.4
	Total	339	9.8±0.7	7.8-17.4
Splenic thickness (cm)	0-12	118	7.6±0.6	6.0-11.5
	13-27	112	7.9±0.6	6.9-12.8
	28-40	109	8.7±0.7	7.5-12.9
	Total	339	8.1±0.8	6.0-12.9
Splenic width (cm)	0-12	118	4.3±0.8	3.1-6.6
	13-27	112	4.7±0.7	3.6-6.9
	28-40	109	5.3±0.6	3.6-7.9
	Total	339	4.7±0.8	3.1-7.9
Splenic volume (cm^3)	0-12	118	307.8±84.5	169.5-710.4
	13-27	112	369.9±82.9	243.4-559.3
	28-40	109	488.9±83.2	282.6-681.3
	Total	339	381.6±111.4	169.5-710.4

SD: Standard deviation, SL: Splenic length

Table 2: Relationship between splenic dimensions and gestational age

Pearson's correlation	Gestational age	
	r	*P*
SL	0.37	0.000*
Splenic thickness	0.26	0.000*
Splenic width	0.20	0.000*
Splenic volume	0.31	0.000*

SL: Splenic length

Table 3: Relationship between splenic dimensions and maternal body mass index

Pearson's correlation	Maternal BMI	
	r	*P*
SL	0.46	0.000*
Splenic thickness	0.30	0.000*
Splenic width	0.34	0.000*
Splenic volume	0.49	0.000*

BMI: Body mass index, SL: Splenic length

with gestational age (r = 0.37 and 0.31, P = 0.000), as shown in Table 2. There was also a significant positive correlation between maternal BMI and SL, splenic thickness, splenic width, and splenic volume (r = 0.46, 0.30, 0.34, and 0.49, $P < 0.05$, respectively), as shown in Table 3. There were weak correlations between SL and splenic volume with maternal age (r = 0.16 and 0.19, P = 0.03) [Table 2].

Discussion

Since the spleen plays significant roles in maintaining a healthy pregnancy, it is necessary to estimate its dimensions in this group of individuals. Splenic dimensioning in prenatal care may offer an additional pathway to clinical decision-making and improve the well-being of the mother and child. Pregnancy is a physiological state that has reportedly influenced various systems of the body which may directly impact on the size of the spleen.[11] As such, the extrapolation of values from normal nonpregnant women to expectant mothers, to a large extent, could be incorrect.[12] The result of our studies shows that the maternal mean SL throughout pregnancy in the present study was 11.9 ± 0.7 cm (it ranged from 6.00 to 17.40 cm), as shown in Table 1, while thickness, width, and splenic volume were estimated as 9.5 ± 0.8 cm, 5.7 ± 0.7 cm, and 381.6 ± 111.4 cm^3, respectively [Table 1].

We observed that the mean splenic dimensions (length, thickness, and width) obtained in the present study surpassed documented measurements in a similar study conducted by Ugboma and Ugboma[11] in Rivers State, Southern Nigeria, albeit their splenic values (length, thickness, and width) were within range with those of the present study (6.0–17.4 cm). Maternal splenic dimensions were seen to demonstrate weak positive correlation with gestational age, which corroborates the work done by Maymon *et al*. conducted in Israel.[12] However, a discordance was seen when our result was compared with a study conducted by Ugboma and Ugboma.[11] In their study, no statistical relationship was established between mean splenic size and gestational age. The reasons for such variations may have been accounted for by other confounding factors such as height irrespective of gestational age, ethnic, dietary, and environmental differences. Chow *et al*.[9] have reported that from documented upper limit of splenic dimension, 6 out of every 100 women of their study cohort would be interpreted as having splenomegaly. In this regard, they argued that factors such as racial, ethnic, and anthropometry could underlie splenic size and measurement should be tailored to integrate population characteristics.

Our study also shows that splenic dimension (length, thickness, width, and volume) had significant positive correlations with

Figure 1: Image showing measurements for splenic length and thickness

BMI of the mother during pregnancy. These findings are in agreement with similar studies conducted in Rivers State, Nigeria, and Israel.[9,12] During pregnancy, there is usually an upsurge of pregnancy hormone and blood flow needed for fetal growth and development.

This upsurge of hormones and blood flow are thought to be responsible for the increased BMI of the pregnant mother. The longer this upsurge persists, the more likely that the mother would gain weight and indirectly leading to an increase in splenic dimensions. However, evidence has linked this weight gain in expectant mothers to the growing fetus, liquor, and placenta.[9] In a study conducted by Ehimwenma and Tagbo[3] on nonpregnant women, the mean splenic volume was stated to be 153.7 ± 33.2 cm^3. Other studies conducted in the south-eastern part of Nigeria have also reported lower values of splenic volume in nonpregnant women.[13,14] The reason for higher splenic volume in the expectant mothers in the present study, compared to other studies for nonpregnant women, has been linked to the upsurge of pregnancy hormones needed for fetal development which indirectly increases splenic size. Another possible explanation is related to hemodynamic changes during pregnancy. Here, blood volume, which increases steadily over the gestation period, accounts for such weight gain during pregnancy[10] and height being a more stable parameter has the strongest effect on spleen size. Splenic size may be an indicator of the well-being of the mother and fetus. The present study has provided useful data on maternal splenic dimension of a sampled population of pregnant women in Nigeria to be used as reference data to improve obstetric care and pregnancy outcome.

Conclusion

Our results show that maternal splenic volume increases with gestational age in normal singleton pregnancy in this region. Pregnancy may therefore be seen as a factor to be considered when assessing splenic volume and dimension. Knowledge of splenic dimensions could improve clinical decision-making and transform care in obstetrics.

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Conflicts of interest

There are no conflicts of interest.

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